Claims

1. An optical pulse regenerator comprising means for broadening the temporal widths and flattening the centre portions of an optical pulse in optical communication using a saturable absorber such as, an unbalanced optical interferometer, and with an optical amplifier.

2. An optical pulse regenerator according to claim 1, where the means for broadening the temporal widths and flattening the centre portions of an optical pulse comprises a section of optical fibre having a negative dispersion coefficient, that is a section of normal dispersion fibre.

3. A regenerator according to claim 2, wherein, for a defined amount of pulse amplification by the optical amplifier, the adequate length of the normal dispersion fibre for a suitable power level at the fibre output is determined by the trade-off between the effects of dispersion, non-linearity and attenuation in the fibre.

4. A regenerator according to any preceding claim, wherein the unbalanced interferometer is a Sagnac interferometer and preferably a fibre optic Sagnac interferometer.

5. A regenerator according to claim 4, wherein the interferometer is a non-linear loop mirror.

6. A regenerator according to claim 5, wherein the non-linear loop mirror comprises a 2 x 2 optical coupler, a first port on one side of the coupler forming the input to the non-linear optical loop mirror, the second port on the one side forming the output to the non-linear optical loop mirror, and the ports on the other side of the coupler being connected together by a section of optical waveguide, to form a waveguide loop.

7. A regenerator according to claim 6, wherein the optical coupler is a fibre optic coupler or a semiconductor waveguide device, and the optical waveguide comprises a section of optical fibre and/or a section of semiconductor waveguide.

8. A regenerator according to any of claims 5 to 7, wherein the non-linear loop mirror is an absorption non-linear loop mirror, comprising an absorption element asymmetrically located within the fibre loop, or an amplifying non-linear loop mirror,

comprising an optical amplifier asymmetrically located within the fibre loop, or a dispersion unbalanced non-linear loop mirror, or an unbalanced coupler non-linear loop mirror.

9. A regenerator according to any of claims 5 to 8, wherein the non-linear loop mirror operates within a region of its switching curve in which the output power of the non-linear loop mirror is substantially stable against small changes in the output power from the means for pulse broadening and flattening.

10. A regenerator according to claim 10, wherein the non-linear loop mirror operates in the region just after the first peak of its switching curve.

11. A regenerator according to any preceding claim, wherein the optical amplifier adjusts the pulse power to a suitable level for input to the saturable absorber such as just after the first peak of its switching curve of the non-linear loop mirror.

12. A regenerator according to any of claims 5 to 10, wherein the length of the loop is determined in terms of the input power to the non-linear loop mirror.

13. A regenerator according to any of claims 5 to 10, wherein the non-linear loop mirror fibre loop is a loop of dispersion-shifted fibre.

14. A regenerator according to any preceding claim, wherein the optical amplifier is a lumped erbium-doped fibre amplifier or a distributed Raman fibre amplifier.

15. A regenerator according to claim 14, wherein the normal dispersion fibre providing means for pulse broadening and flattening is used as the amplifying medium.

16. A regenerator according to claim 15, wherein the distributed Raman fibre amplifier is bi-directionally pumped by a forward pump and a backward pump, or the pumping is realised in a single direction, either co-directionally with the propagating signal or counter-directionally and accordingly has one pump.

17. A regenerator which combines the intensity filtering action of a saturable absorber, such as a non-linear loop mirror, for achieving 2R regeneration of an optical signal with broadening of the temporal widths and flattening of the centre portions of an optical pulse, such as produced by dispersion and non-linearity in a normal dispersion fibre, for improvement of the signal phase margin.

18. A regenerator according to claim 17, whose application in optical communication provides both suppression of noise and radiative background in the zero timing slots of an optical signal and reduction of the amplitude jitter of ones, and reduction of the impact of timing jitter without increasing the intersymbol interference.

19. An optical pulse regenerator according to claims 18 for use in an optical transmission system such as a transmission system employing single-channel optical data signals or wavelength-division multiplexed data signals.

20. An optical pulse regenerator according to claim 19, which is applied in optical transmission systems after signal demultiplexing.

21. An optical pulse regenerating component within an optical return-to-zero receiver having the features of the regenerator of any of claims 1 to 20.

22. An optical pulse regenerating unit/component according to claim 21 for improving the signal quality before detection.

23. An optical pulse shaper for transferring return-to-zero optical pulses to non-return-to-zero-like pulses having the features of the regenerator of any of claims 1 to 20.

24. An optical pulse shaper according to claim 23, wherein the transfer of return-to-zero pulses to non-return-to-zero-like pulses occurs through broadening of the temporal widths and flattening of the centre portions of pulses, such as produced by dispersion and non-linearity in a normal dispersion fibre.

25. An optical pulse shaper according to claims 23 or 24, which produces non-return-to-zero-like pulses having a rectangular-like temporal profile or a parabolic temporal profile.

26. An optical pulse regenerating unit comprising a housing containing components of a regenerator according to any preceding claim.

26. A method of regenerating a signal of optical pulses comprising the steps of; amplifying the pulse power, transmitting the signal through a section of fibre with

negative dispersion coefficient to broaden the widths and flatten the centres of the pulses through dispersion and Kerr non-linearity and transmitting the amplified broadened and flattened signal through a saturable absorber such as an unbalanced NOLM to reduce pulse distortion and amplitude noise.

27. The use of an unbalanced interferometer and a fibre with negative dispersion coefficient to reduce the effects of pulse distortion, amplitude noise and timing jitter in regenerating an optical pulse signal.